1. **Name of Experiment/Project/Collaboration:** CUORE, CUORE-IHE
2. **Physics Goals**
    a. **Primary:** Neutrinoless Double-Beta Decay
    b. **Secondary:** Direct dark matter, axion searches
3. **Expected location of the experiment/project:** LNGS
4. **Neutrino source**: none (^{130}Te DBD isotope)
5. **Primary detector technology:** cryogenic bolometers
6. **Short description of the detector:** close-packed array of bolometric crystals, operating at the base temperature of ~10 mK. CUORE-IHE will employ additional sensors for particle identification and background rejection, such as light sensors for Cherenkov radiation or scintillation, or surface-sensitive sensors.
7. **List key publications and/or archive entries describing the project/experiment.**
    - "Searching for neutrinoless double-beta decay of ^{130}Te with CUORE", D.R. Artusa et al., arXiv:1402.6072
    - "Exploring the Neutrinoless Double Beta Decay in the Inverted Neutrino Hierarchy with Bolometric Detectors", D.R. Artusa et al., Eur.Phys.J. C74, 3096 (2014).
8. **Collaboration**
    a. **Institution list (CUORE):**

Department of Physics and Astronomy, University of South Carolina, Columbia, SC 29208 - USA
INFN - Laboratori Nazionali del Gran Sasso, Assergi (L'Aquila) I-67010 - Italy
INFN - Laboratori Nazionali di Legnaro, Legnaro (Padova) I-35020 - Italy
Department of Physics, University of California, Berkeley, CA 94720 - USA
Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720 - USA
INFN - Sezione di Bologna, Bologna I-40127 - Italy
Materials Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720 - USA
Dipartimento di Fisica, Sapienza Università di Roma, Roma I-00185 - Italy
INFN - Sezione di Roma, Roma I-00185 - Italy
INFN - Sezione di Genova, Genova I-16146 - Italy
Dipartimento di Fisica, Università di Milano-Bicocca, Milano I-20126 - Italy
INFN - Sezione di Milano Bicocca, Milano I-20126 - Italy
Shanghai Institute of Applied Physics, Chinese Academy of Sciences, Shanghai 201800 - China
Dipartimento di Fisica, Università di Genova, Genova I-16146 - Italy
Dipartimento di Ingegneria Civile e Meccanica, Università degli Studi di Cassino e del Lazio Meridionale, Cassino I-03043 - Italy
Dipartimento di Scienze Fisiche e Chimiche, Università dell'Aquila, L'Aquila I-67100 - Italy
Department of Physics, Yale University, New Haven, CT 06520 - USA
Department of Physics, University of Wisconsin, Madison, WI 53706 - USA
INFN - Gran Sasso Science Institute, L'Aquila I-67100 - Italy
INFN - Laboratori Nazionali di Frascati, Frascati (Roma) I-00044 - Italy
Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse, 91405 Orsay Campus - France
Physics Department, California Polytechnic State University, San Luis Obispo, CA 93407 - USA
Department of Materials Science and Engineering, University of California, Berkeley, CA 94720 - USA
Massachusetts Institute of Technology, Cambridge, MA 02139 - USA
Department of Physics and Astronomy, University of California, Los Angeles, CA 90095 - USA
Physics Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720 - USA
Laboratorio de Fisica Nuclear y Astroparticulas, Universidad de Zaragoza, Zaragoza 50009 - Spain
Dipartimento di Scienze per la Qualità della Vita, Alma Mater Studiorum - Università di Bologna, Bologna I-47921 - Italy
Service de Physique des Particules, CEA / Saclay, 91191 Gif-sur-Yvette - France

Lawrence Livermore National Laboratory, Livermore, CA 94550 - USA
Department of Nuclear Engineering, University of California, Berkeley, CA 94720 - USA
INFN - Sezione di Padova, Padova I-35131 - Italy
Dipartimento di Fisica, Università di Firenze, Firenze I-50125 - Italy
INFN - Sezione di Firenze, Firenze I-50125 - Italy
SUPA, Institute for Astronomy, University of Edinburgh, Blackford Hill, Edinburgh EH9 3HJ - UK
Dipartimento di Fisica e Astronomia, Alma Mater Studiorum - Università di Bologna, Bologna I-40127 – Italy

CUORE-IHE Interest Group:

High Energy Physics Division, Argonne National Laboratory, Argonne, IL, USA
Materials Science Division, Argonne National Laboratory, Argonne, IL, USA
INFN - Laboratori Nazionali del Gran Sasso, Assergi (AQ), Italy
Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA
Department of Nuclear Engineering, University of California, Berkeley, CA, USA
Department of Physics, University of California, Berkeley, USA
Università di Bologna and INFN Bologna, Bologna, Italy
Massachusetts Institute of Technology, Cambridge, MA, USA
Department of Physics and Astronomy, University of South Carolina, Columbia, SC, USA
Technische Universität München, Physik-Department E15, Garching, Germany
Dipartimento di Fisica, Università di Genova and INFN - Sezione di Genova, Genova, Italy
Institute for Nuclear Research, Kyiv, Ukraine
INFN - Laboratori Nazionali di Legnaro, Legnaro, Italy
Lawrence Livermore National Laboratory, Livermore, CA, USA
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INFN sez. di Milano Bicocca and Dipartimento di Fisica, Università di Milano Bicocca, Italy
State Scientific Center of the Russian Federation - Institute of Theoretical and Experimental Physics (ITEP), Moscow, Russia
Max-Planck-Institut für Physik, D-80805 München, Germany
Nikolaev Institute of Inorganic Chemistry, SB RAS, Novosibirsk, Russia
Sobolev Institute of Geology and Mineralogy, SB RAS, Novosibirsk, Russia
Centre de Sciences Nuclèaires et de Sciences de la Matière (CSNSM), CNRS/IN2P3, Orsay, France
INFN - Sezione di Padova, Padova, Italy
Institut de Chimie de la Matière Condensè de Bordeaux (ICMCB), CNRS, 87, Pessac, France
Dipartimento di Fisica, Università di Roma "La Sapienza" and INFN - Sezione di Roma, Roma, Italy
IFN-CNR, Via Cineto Romano, I-00156 Roma, Italy
Service de Physique des Particules, DSM/IRFU, CEA-Saclay, France
Physics Department, California Polytechnic State University, San Luis Obispo, CA, USA
Shanghai Institute of Applied Physics (SINAP), China
Institut de Physique Nuclèaire de Lyon, Universitè Claude Bernard, Lyon 1, Villeurbanne, France
Wright Laboratory, Department of Physics, Yale University, New Haven, CT, USA
Laboratorio de Fisica Nuclear y Astropartculas, Universidad de Zaragoza, Zaragoza, Spain

b. **Number of present collaborators:** 126
c. **Number of collaborators needed:** CUORE-IHE is open to expression interest from experienced collaborators

9. **R&D**
   a. **List the topics that will be investigated and that have been completed:**
   CUORE-IHE: operation of a tonne-scale detector (CUORE), development of high-resolution photon sensors, production of scintillating bolometer crystals, pulse-shape discrimination of surface events, purity and efficient use of enriched material, material screening and selection, cosmic ray veto
   b. **Which of these are crucial to the experiment:** all are important for achieving the ultimate sensitivity and science goals.
   c. **Time line:** CUORE operations: 2015-2021; CUORE-IHE R&D: now-2017
   d. **Benefit to future projects:** low-background techniques and material selection are common to many DBD and dark matter experiments. High-resolution bolometric detectors are also used in astrophysics, X-ray spectroscopy, dark matter searches, and direct neutrino mass measurements. Finally, discovery of Majorana neutrinos would have a profound effect on our understanding of the Universe.
10. **Primary physics goal expected results/sensitivity**:
   a. **For exclusion limit (such as sterile neutrino search), show 3-sigma and 5-sigma limits**
   b. **For discovery potential (such as the Mass Hierarchy), show 3-sigma and 5-sigma.**
   c. **For sensitivity plots, show 3-sigma and 5-sigma sensitivities**
   (note that for neutrino-less double beta decay experiments that have previously been asked for 90% CL and 5 sigma limits these are OK)
   ^{130}Te $0\nu\beta\beta$ half-life sensitivities after 5 years of operation: CUORE: 10^{26} years (90% C.L.) and 0.3×10^{26} years (5σ). CUORE-IHE, depending on the isotope of choice: 90% C.L.: 6.5×10^{26} (^{100}Mo), 2.2×10^{27} (^{82}Se), 2.6×10^{27} (^{130}Te), 1.5×10^{27} (^{116}Cd) years; 5σ: 1.9×10^{26} (^{100}Mo), 0.8×10^{27} (^{82}Se), 0.9×10^{27} (^{130}Te), 0.5×10^{27} (^{116}Cd) years. With these sensitivities, the discovery potential corresponds to effective Majorana neutrino masses in, or above, the inverted hierarchy region.
   d. **List the sources of systematic uncertainties included in the above, their magnitudes and the basis for these estimates**: sensitivity estimates are based on detailed modeling of backgrounds, measurements in Cuoricino and CUORE-0, and expected improvements in detector technology. The largest uncertainty, at this point, is reliability and uptime of the large cryogenic installation, which will be demonstrated with CUORE.
   e. **List other experiments that have similar physics goals:** nEXO, Majorana/Gerda, KamLAND-Zen, NEXT, SNO+, SuperNEMO, and others.
   f. **Synergies with other experiments**: bolometric technology is used in CMB measurements, dark matter detection (CDMS, CRESST, EDELWEISS), direct neutrino mass measurements (HOLMES , ECHO), and others.
11. **Secondary Physics Goal**
   a. **Expected results/sensitivity:** CUORE would be sensitive to dark matter signals in the region of parameter space covered by DAMA, CoGENT, and CRESST. Depending on the chosen technology, CUORE-IHE may improve on this sensitivity, especially in the low mass region of WIMP parameter space.
   b. **List other experiments that have similar physics goals:** SuperCDMS, EDELWEISS, CRESST

12. **Experimental requirements**
    a. **Provide requirements (neutrino source, intensity, running time, location, space,…) for each physics goal:** underground lab with overburden of at least 3600 mwe (LNGS or deeper) and utilities, space of about 10x10x10 m^3, low-activity materials, radio-assay capabilities with sensitivity of ~ppt, about one metric ton of enriched isotope. Expected running time: 5-10 years
13. **Expected Experiment/Project time line (technically-limited schedule)**
    a. **Design and development:** CUORE-IHE R&D: now-2017, project engineering: 2018-2019
    b. **Construction and Installation:** CUORE: now-2015; CUORE-IHE: 2019-2022
    c. **First data:** CUORE: 2015; CUORE-IHE: ~2022
    d. **End of data taking:** CUORE: ~2020-2021; CUORE-IHE: ~2030
    e. **Final results:** approximately one year after final data taking
14. **Estimated cost range**
    a. **US contribution to the experiment/project:** CUORE: $10M (DOE-NP, NSF)
    b. **International contribution to the experiment/project:** CUORE: ~$20M
    c. **Operations cost:** ~$250k/year
15. **The Future**
    a. **Possible detector upgrades and their motivation:** CUORE-IHE is the next-generation, tonne-scale DBD detector, capable of discovering Majorana neutrinos if they exist in or above the inverted hierarchy neutrino mass range. Its technology and infrastructure are based on CUORE. If neutrinoless double-beta decay is discovered in one of the isotopes, a similar detector, with the same infrastructure, can utilize other isotopes to confirm the discovery, and study the mechanism of neutrinoless double-beta decay with high precision.
    b. **Potential avenues this project could open up:** discovery of Majorana neutrinos will have a profound effect on our understanding of Nature.